Towards a Graphene Nanoelectrode Single-Molecule Biosensor Utilizing Quantum Tunneling

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Electronic single-molecule biosensors have attracted considerable attention given their promise to drive a shift in areas as diverse as rapid diagnostics, precision medicine, and DNA data storage. Here we report on the fabrication progress and initial data from a solid-state single-molecule graphene nanogap based biomolecular sensor architecture[1]. The device which utilizes a nanometer-scale graphene gap co-aligned with a nanoscale substrate aperture below and passivation layer above, permits simultaneous transverse and transmembrane analyte measurements. This architecture allows standard nanopore analysis techniques[2] to be utilized in the transmembrane axis, while enabling novel recognition tunneling techniques[3] to be utilized in the transverse axis.

Briefly, the device is fabricated on a suspended $SiN/SiO_2/Si$ architecture with metal electrodes fabricated via electron beam lithography and thermal evaporation. Apertures in the SiN, allowing for the translocation of DNA, are fabricated via focused ion beam milling and the graphene nanogaps are formed via a combination of electron beam lithography and feedback-controlled electroburning[4]. The graphene is passivated via a dielectric coating with an electron beam lithography fabricated co-aligned aperture, resulting in a single translocation pathway through the device. The architecture, which requires aligned <10nm features in multiple layers, is characterized with SEM, AFM, and S/TEM. Initial recognition tunnelling data from analytes will be presented.

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3. Lindsay, S. et al. Recognition tunneling. Nanotechnology 21, 262001 (2010).
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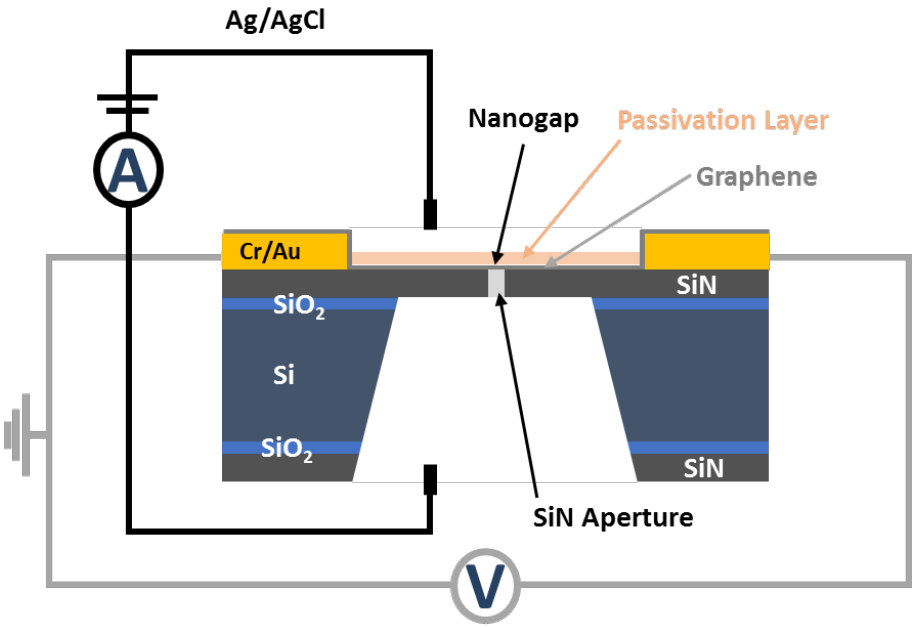

Figure 1: Schematic illustrating the architecture and sensing configuration of an electronic single-molecule graphene nanogap enabled biosesning device.

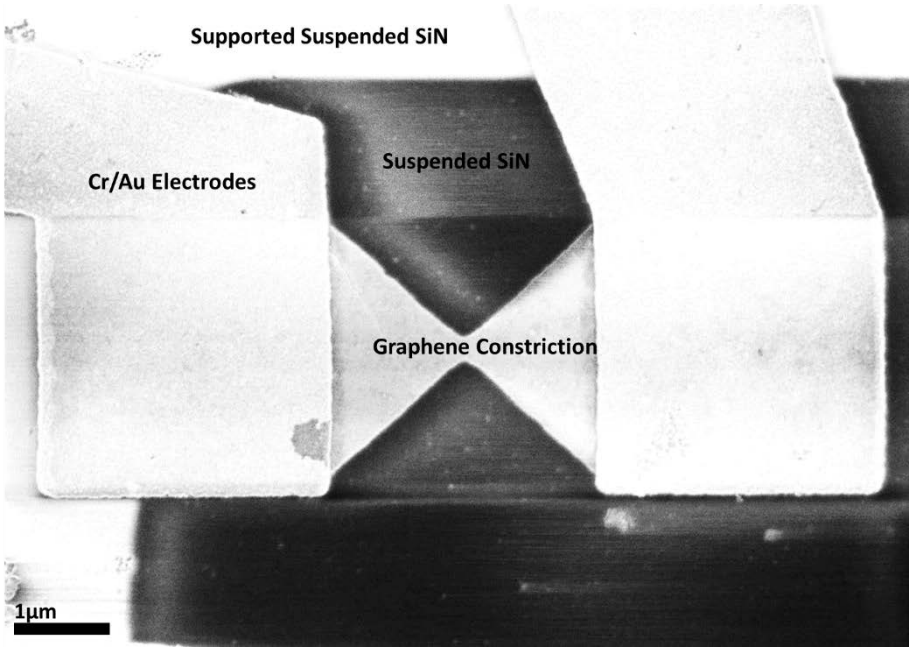

Figure 2: Scanning electron microscope image of a graphene nanogap covering a SiN aperture, contacted with Cr/Au electrodes, prior to passivation.